# The Structure of Science Writing BISC110

**Types of Scientific Papers found in science publications:**

**Original (primary) research report:** Based on experimental findings published by the authors (primary literature)- primary study; meta-analysis

**Research Review (secondary literature) –** Overview of research on a topic

**Opinion-** Editorial, perspective, commentary, correspondence, forum

**Parts of a Scientific Paper:**

**Title**
**Abstract**
**Introduction**
**Materials & Methods**
**Results**
**Discussion**
**References**

**Title:** Includes all key words. Usually gives main finding or topic.

## Abstract

It's a brief **summary** of the entire paper. **What goes in a good abstract?** In a research report (primary study):

**General Topic & Broad Significance:** Move from broad to narrow and from old to new information (usually includes experimental questions or goals).

**Methods:** *Very* general, no detail: *Brief* description of the basic experimental design for measurements, often included as part of the description of findings (results).

**Findings**: Experimental results from most to least important or from broad to narrow. Include overall conclusions that address the experimental question(s).

**Broader significance:** How the findings or conclusions from *this* study are applicable to a broader context, or where the research findings lead.

## Introduction

**What goes in it & in how much detail? In this order:**

**Topic & Significance-** Gets the reader interested or to care about the broad topic. The topic sentence in a paragraph gives the context (links backwards or provides framework for everything in the paragraph). The topic paragraph ends with a statement of this investigation's experimental goals. (Remember that the last sentence of each paragraph and the last few words of each sentence is the stress position. Save the most important new information for last.)

**Background information-** Moves from old to new and broad to narrow. Summarizes the history of the most important findings on the topic (with in text citations to *original* authors' published studies (don't cite review articles' authors). Includes ONLY the minimum information necessary for a reader, who is not an expert in the field, to understand the context and the concepts involved in the investigation. If the experimental tools are complex, may include background information needed to

understand how the measurement system is related to the goals. Background may be more than one paragraph.

**Brief general outline of the experimental question(s) and experimental design.** Because the Materials and Methods sections (or the Results section in some journals) comes after this concluding paragraph, this general outline serves to summarize this study's investigative goals and how they were achieved experimentally. It is in the stress position of this section (last) because it's a summary of the important work the study attempted. The last paragraph also transitions to the M&M or Results. You will observe when you read journal articles that, sometimes, the introduction ends with a summary of the main findings but, more often, only the abstract and discussion sections include the study's conclusions. In BISC110 you will *NOT* include conclusions in the introduction.

**Full Reference Citations** are included in a **Reference** page at the end of the paper in the format of the journal *Cell*. The text must cite all background information that is not common knowledge. Common knowledge is information that is found in textbooks without credit to the investigators who discovered and published the finding. You do NOT need to cite a textbook or general reference but you DO need to credit more specific, seminal discoveries such as Drayna's discovery of the taster gene and Fox's original discovery of the phenotype. You must cite the original published studies reporting those findings rather than a review article or our lab wiki where you read about them. Often the introduction serves as a bibliography of the most important previous studies on this topic; therefore, when you write your introduction, it will be helpful for you to look at the references cited in other published papers on your topic to find the articles you will likely want to use as references in your topic and background paragraphs.

## Materials & Methods:

M&M describes each experiment in enough detail so that a savy researcher who knows the tools and techniques of the field has enough information to perform a similar experiment. Often citations showing where to find the protocol details are used in lieu of the full protocol. The Materials and Methods section is usually found just after the introduction but this placement is subject to journalistic convention. Methods are commonly found at the end of the paper, occasionally included as part of the references as "Notes". (*Science* Magazine is an example.)

## Results:

The results section contains both graphics and a descriptive, analytical narrative. The graphics are in the form of figures and/or tables displaying processed data. (Raw data is usually not included except in an appendix or supplement.) Data is processed with the goal of making a reader (who is unfamiliar with the experiment) able to visualize the main point(s) without needing to read the figure's caption (often called a legend) or the author's explanatory text narrative.

The text narrative starts by stating, briefly, the goal(s) of the experiment shown in the first figure or table and how that experiment relates to the overall goals of the investigation. Next, outline how the first experiment described was conducted (briefly and generally and NOT in the detail of the Materials and Methods). This summary gives

context for the description of experimental findings that will follow. The narrative next both describes and analyzes the experimental data to allow conclusions to be made from experimental findings. The narrative refers to the data by figure or table number and does not merely describe the data shown in the figure but analyzes it to explain how or why those data are able to answer an experimental question. It makes a conclusion statement IF a conclusion can be made from those data alone. Each results section, generally, does not bring in outside sources or put different experiments in this investigation together. (Save that integration for the discussion section.) The order of the experimental data presented in the results section should be logical rather than, necessarily, chronological.

**Figures, Tables & Legends:**

Insert each figure or table at the end of the paragraph where it is introduced in the narrative. A good figure makes the significance of the findings clear to any reader, visually and easily. The caption or legend that accompanies each figure includes (or directs the reader where to find) all information needed to understand the experiment, how the data were generated, and how to interpret any symbols or ambiguous terms. Tutorial in DianaHacker.com on generating an effective figure from data: http://bcs.bedfordstmartins.com/rewriting/wr8.html

## Discussion:

The discussion begins with a *brief* summary of the experimental goals, findings and conclusions and includes figure or table numbers where those experimental findings are found. It puts the findings described and analyzed in results in context with other research (citing all sources). It compares the findings in this study to others work in the same field or on the same topic and attempts to validate or refute previous work, to take knowledge in the field farther, or to change the direction of thinking and research in the field. Like the introduction, a good discussion cites the information from outside sources in the format requested.

The discussion "discusses the questions that naturally arise from the results". It, essentially, starts where the results section ends, offering *possible* explanations to the questions, "why did what I observed happen?"; "what is likely to be the biological mechanism behind my observations even though my experiment doesn't answer that?" That said, do not "leave your data behind". The discussion should be centered around *your* study's findings. Make sure that you make your argument, first and foremost, using your data as evidence (specifically referencing the figure/table#) and using outside information only to make your conclusions stronger, weaker, or add complexity. Do more than mention outside relevant research. Instead, explain specifically what other researchers found that relates to your findings and conclusions and include, briefly, how their methods differed or were similar to yours..

How much of the discussion addresses the significance of your findings or takes your conclusions and applies them to a broader context depends on the audience. In narrow audience publications, the discussion is less likely to apply the experimental conclusions more broadly. If the journal has a more general audience (*Science*, *Nature*, or *Lancet*) one of the main goals of the discussion is to take the findings and conclusions presented in the results narrative and show the reader that the findings have wide applicability or

significance. For BISC110, you will think of your paper as a broad audience journal so do try to find a larger context for your findings.

## References:

There are many widely accepted formats for citing sources. The journal of BISC110 will use the citation style of the Journal *Cell*. This is a "name/year" style, meaning that the author's last name is followed by the year of publication is put in parenthesis at the end of the sentence containing information from that source (Author, Year). A reference list at the end of the paper is called REFERENCES and is organized alphabetically by first author's last name. The best way to learn to use a specific citation format is to go to the Wellesley library's e-subscription to *Cell* and look at research reports in recent issues for models of how different types of sources are cited and how those citations are formatted. (http://www.cell.com/archive). There are several on-line reference management systems such as ENDNOTE that can make keeping track of and formatting references much easier. If you would like to learn about them, see Wellesley's science librarian, Neil Nero who can get you started.